



PLASMA SCIENCE AND FUSION CENTER

COMMENTS

Miklos Porkolab

Director

**OFES Budget Planning Meeting
March 15-16, 2005
Gaithersburg, MD**



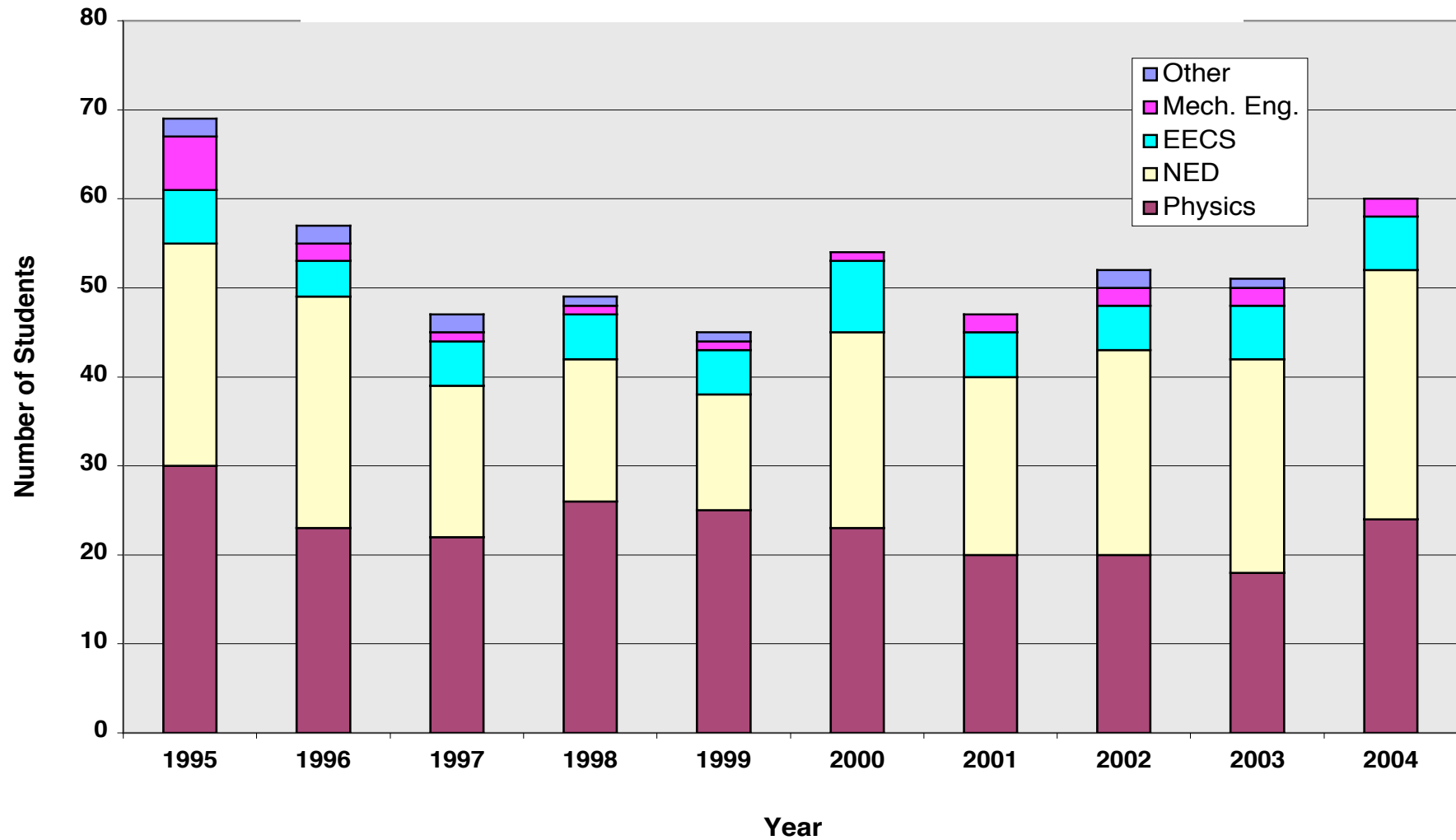
PSFC PERSONNEL

(3/15/05)

	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY 05</u>
Undergraduate Students	6	5	9	17	15	16
Graduate Students	54	47	52	56	57	61
Faculty/Sr. Academic	18	16	18	18	18	18
Engineering/Scientific Research Staff	65	68	72	73	73	78
Administrative Staff	10	12	13	12	11	11
Support Staff	11	9	10	13	14	13
Technicians/Drafters	<u>28</u>	<u>30</u>	<u>30</u>	<u>31</u>	<u>31</u>	<u>30</u>
	192	187	204	220	219	227
Visiting Scientists & Staff Engineers	58	54	61	53	50	43
TOTAL	250	241	265	273	269	270

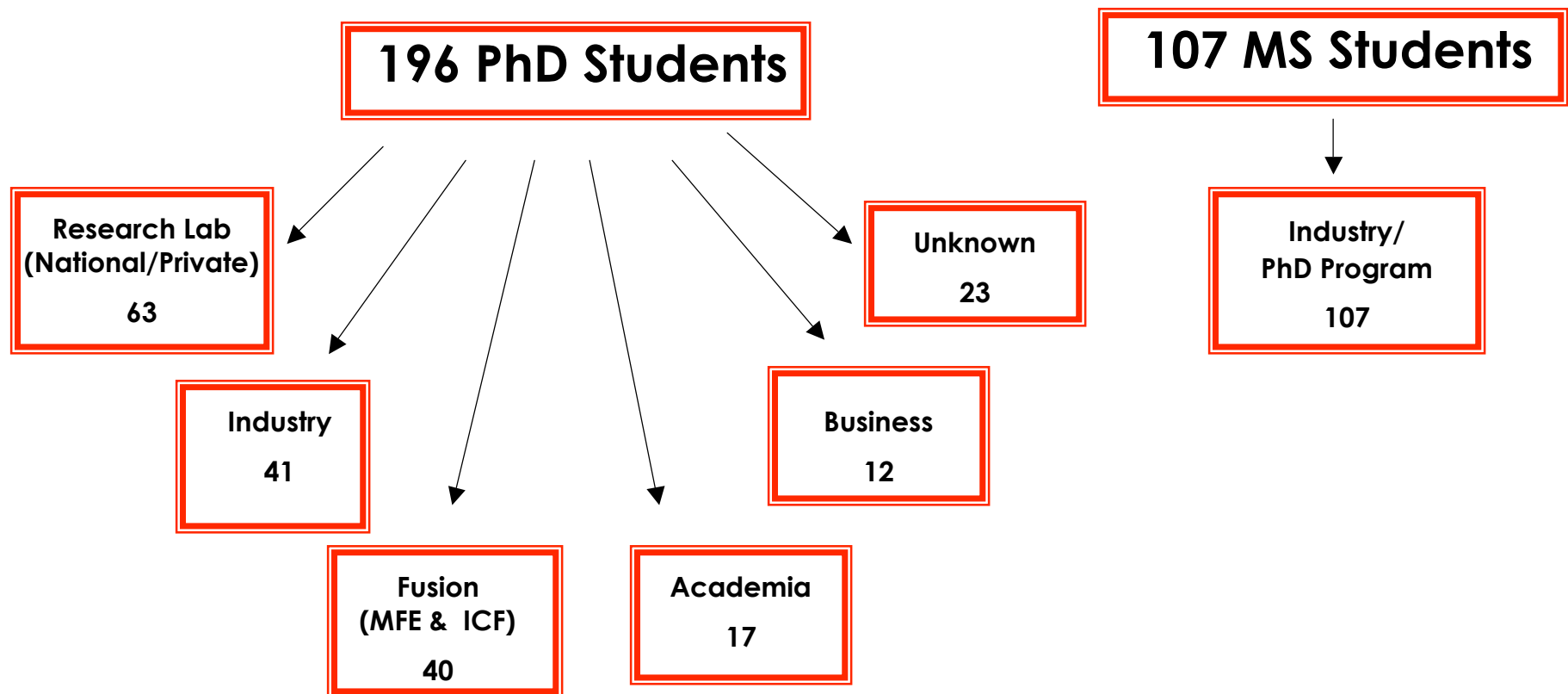


Total Number of PhD Students at the PSFC Per Year





Employment Status of MIT PSFC PhD/MS Students Beyond Graduation (1980–2004)





PSFC BUDGET PROFILE BY DIVISIONS

PSFC DIVISION	FY04 Budget	Projected FY05 Budget	Projected FY06 Budget	Add-on FY06B Budget	Projected FY07 Budget	Add-on FY07B Budget
Physics Research: M. Porkolab	3,149	3,197	3,126	401	3,136	457
Waves and Beams: R. Temkin	885	1,158	1,590	16	1,590	16
Alcator Division: E. Marmor	19,727	19,518	19,073	6,824	19,897	6,365
Plasma Technology and Systems: D. Cohn	418	427	427	0	427	0
Fusion Technology and Engineering: J. Minervini	2,895	3,054	3,942	282	3,942	282
DOE OFES Total:	27,074	27,354	28,158	7,523	28,992	7,120

Budget projection does not account for significant increases needed for Fusion Technology Division in FY 06, 07 if ITER were to proceed to construction



PHYSICS RESEARCH DIVISION Experiments

A. Levitated Dipole Experiment (LDX) (Columbia-MIT Collab.)

Experimentation begun 8/04. Have achieved $\beta \sim 7\%$.

Additional funding for Fy 06 would increase run time and student RA

B. Driven Magnetic Reconnection Experiments on VTF

Newly funded by OFES in FY04; two PhD students on ORISE DOE fellowship make marginal project funding functional; Participating in OFES funded “Center for Multi-Scale Plasma Dynamics” ; need technician

C. Advanced Diagnostics

- (1) Phase Contrast Imaging (PCI) upgrade proceeding on DIII-D and C-Mod to look for short wavelength modes (ETG, TEM, IBW, ICW)
- (2) Collective Thomson Scattering upgrade on TEXTOR, ASDEX-U:
(An MIT PSFC- RISO/Denmark collaboration)

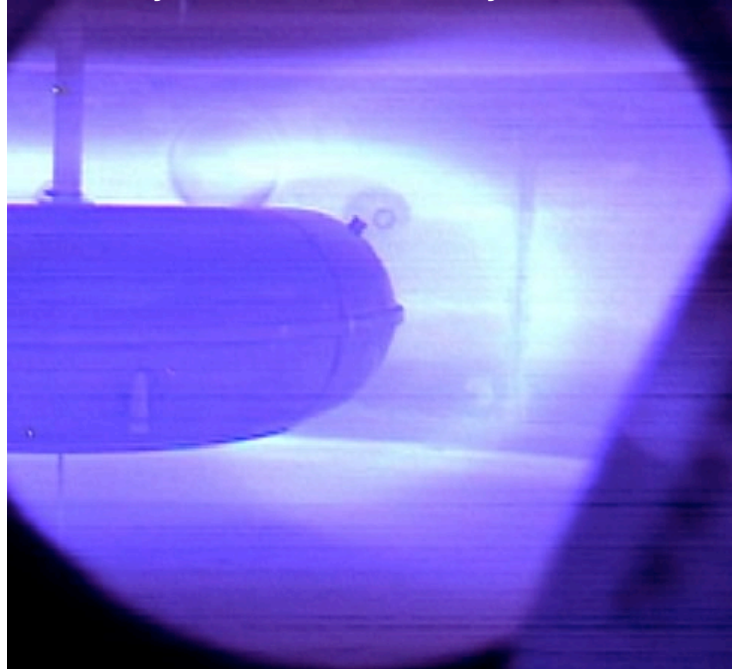
D. JET-MIT PSFC Collaboration on TAE modes

MIT-JET-CRPP collaboration-New antenna fab for JET by CRPP
Will ask for renewal of Grant in December, 2005

F. HEDP

Participating in new OFES Science Center with Univ. Rochester

LDX Physics Studies Underway Summer 2004!



A partnership of innovative plasma science and magnet technology

Completed fabrication and integrated testing of high-field superconducting magnets in FY04

US Fusion Program's only ongoing experiment with superconducting magnets

Can fusion benefit from nature's way to confine high-beta plasma ?

FY04-05 Achievements

Phase 1: Plasma experiments with supported coil (now).

Phase 2: Plasma experiments with levitated coil on-track for Summer 2005.

FY06 Campaign

- Continue basic physics explorations of high-beta, high-temperature plasma confined by levitated dipole magnet

FY07 Campaign ("Full Use Budget")

- Investigate the unique capability of a dipole for high plasma beta confinement,

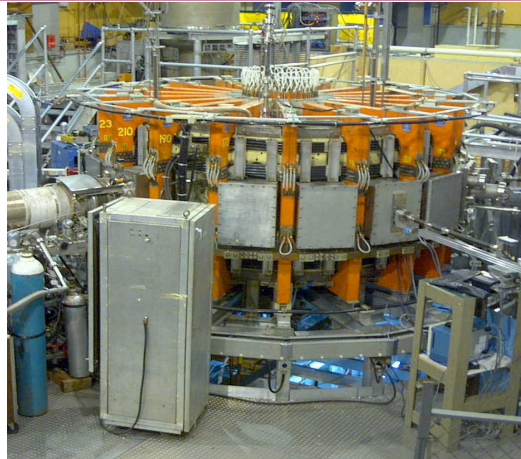
.Funding reduction (-10%): would limit purchase of cryogenics needed to run superconducting magnets and eliminate support for a graduate student.



Reconnection Experiments in VTF in the Open Configuration

Provided Understanding of the WIND Satellite Data (60 R_{Earth})
(VTF is now a member of the Center for Multi-Scale Plasma Dynamics)

(A)

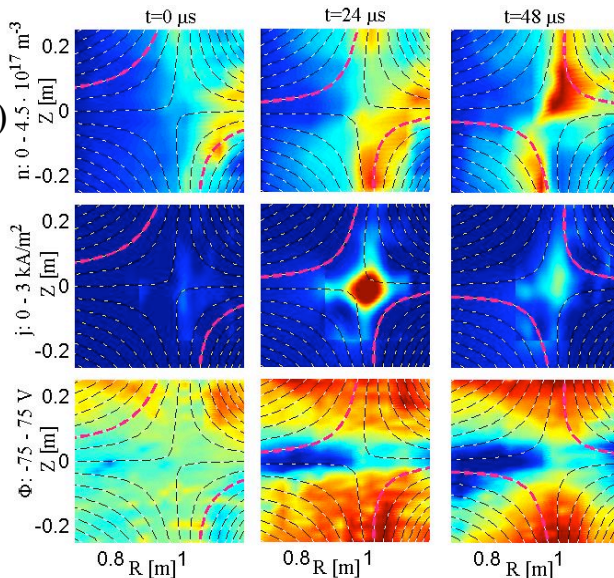


(A) The Versatile Toroidal Facility (VTF)

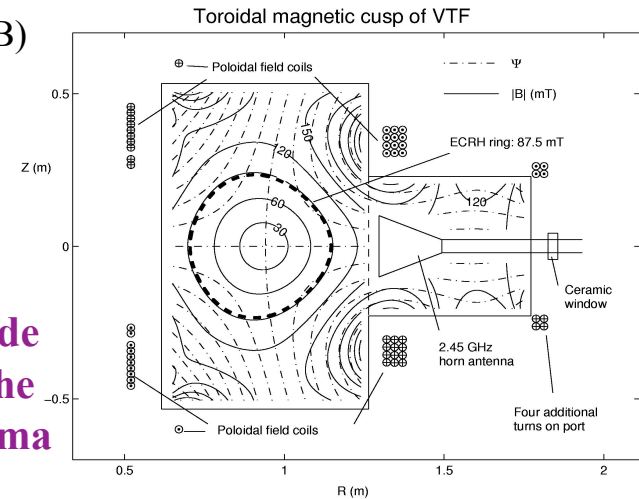
(B) Open magnetic field configuration

(C): Measurements provide detailed information on the time evolution of the plasma density, current and electrostatic potential

(C)



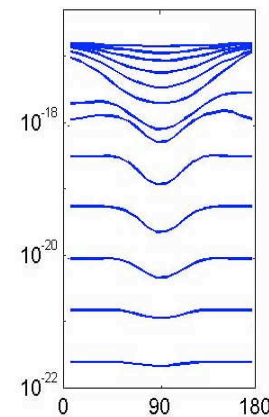
(B)



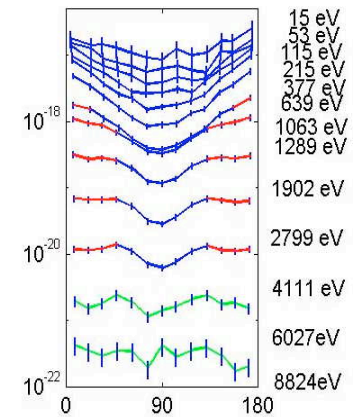
(D)

(D) **RIGHT:** Electron distribution measured by the WIND satellite during passage through the Earth's magnetotail at 60 R_{Earth} . **LEFT:** The VTF orbit kinetic code reproduces the WIND data during magnetic reconnection.

VTF Model



Wind Meas.



J. Egedal et al., (2005) Phys. Rev. Lett. **94**, 025006



PSFC Theory Group (Peter J. Catto, Head)

- PSFC theorists participating in 3 new SCiDAC proposals

Funding of one or more of these should help retain key staff and students and provide support for ongoing experiments (C-Mod, LDX, VTF) and ITER

- Theory Grant Proposal is being prepared for submission for renewal
- Spectacular new results with the new 48 parallel processor cluster

New request for FY 06/07:

- Propose to upgrade cluster to 128 processors at a cost of \$150K

Request \$75K new money from OFES, and the PSFC/C-Mod combination will match these funds (\$75K); in addition, MIT pledged \$50K to upgrade the facilities by increasing the airconditioning capacity (new unit and installation)

- In addition, request \$70K for new student RA

The cluster upgrade would enable us to:

- Non-linear simulations with GS2 and GYRO
- Practical turnaround time for code development and testing
- Converged LH runs for planned C-Mod experiments
- Combining TORIC AND TOPICA ICRF codes (full wave and antenna model)
- Coupled TORIC and CQL3D runs

“Synthetic” PCI Diagnostic Based on TORIC Code Predicts “Footprint” of Slow Kinetic ICRF Waves in Remarkable Agreement with Experiment

RF wave driven density fluctuations
are proportional to the divergence of
the perturbed velocity.

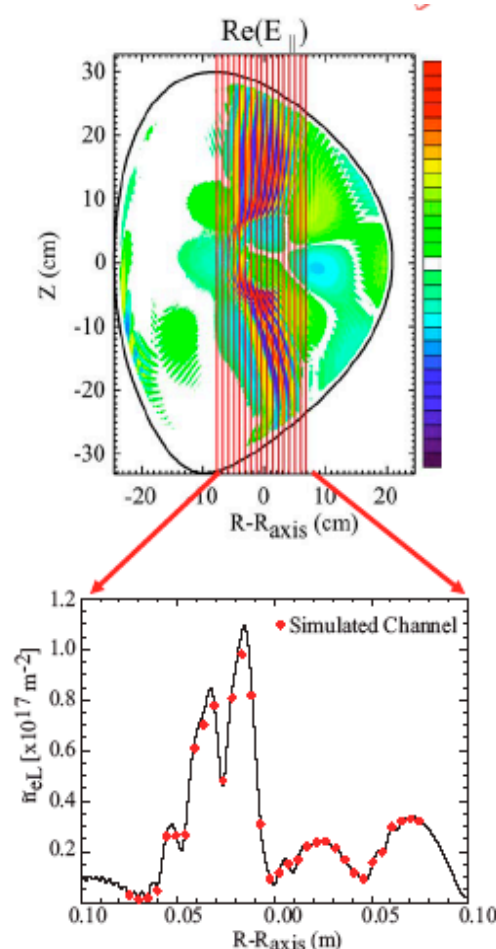
$$\frac{\tilde{n}_e}{n_{e0}} = \frac{-i}{\omega} \nabla \cdot \tilde{\mathbf{v}}_e$$

$$\tilde{\mathbf{v}}_e \equiv -i \frac{\Omega_e}{\omega} \frac{E_\zeta}{B_0} \hat{\zeta} + \frac{E_\eta}{B_0} \hat{\psi} - \frac{E_\psi}{B_0} \hat{\eta}$$

$$\frac{\Omega_e}{\omega} \gg 1 \text{ and } E_\eta \sim E_\psi$$

- Where perturbed velocity and E-field is written in local Stix coordinates.
- Simple rule for predicting dominant contribution is difficult because it is a function of both wavelength and field strength.

Line integrate calculated 2-D
fluctuations and use same analysis
as used for experiment.



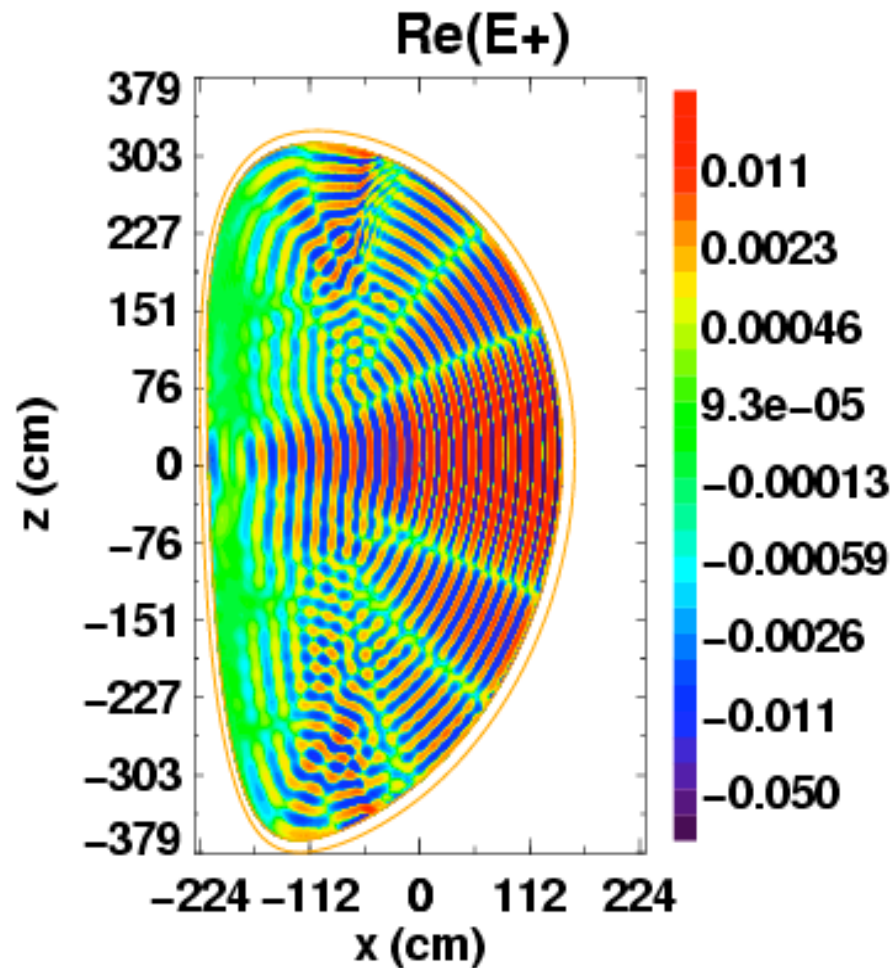
Another Result
on Turbulence:

GS2 Simulations &
Phase Contrast
Imaging Reveal
Trapped Electron
Mode Turbulence
in C-Mod ITB



2nd Harmonic Tritium Heating in ITER (Aries AT 2001 Reference Case used in TORIC)

$T_e=23.5$ keV; $T_i=19.5$ keV; $T(^3\text{He})=0.4$ MeV; $T(\alpha)=1.6$ MeV



❖ MPP version of TORIC can solve for absorption for a single toroidal mode in ITER on 40 processors in 40 minutes

❖ Plan to couple TORIC to CQL3D and Sigma-D to study effects of alphas and fast ions in ITER

❖ Power deposition:

Electrons: 45%;

^3He : 46%;

T: 2%

Alpha: 6%



FUSION TECHNOLOGY PLANS FY 06, 07

- Superconducting magnet R&D spending and plans depend on actual ITER funding for FY 06, 07; see ITER/VLT budget scenarios
- In the PSFC budget table we presented magnet R&D budgets based on only minimal (\$16M) increase for ITER funding for FY 06; no projection for FY 07 was made; however, if ITER were to proceed to construction, magnet funding alone would have to increase by as much as \$22M



SUMMARY of MIT REQUESTS for FY 06/07

- **C-Mod: restore funding in FY 06, to increase run time at least up to 14 weeks (\$500K), with further increases in FY 07**
- **LDX : increase funding by \$155K to increase run-time and student RA**
- **VTF: Addition of one technician needed at \$100K**
- **Theory: Need \$75K matching funds to upgrade computer cluster and additional \$70K to add one more student RA**
- **ECRH : Maintain the VLT base to support graduate student RA work and provide funding for ITER work as included in the VLT/ITER request**
- **Magnets: Maintain the VLT base and provide for ITER \$3.1M in FY06 and at least \$17.2 M in FY07 (assumes no ITER construction startup in FY 06, or higher funding level necessary)**